Integrated Ultra-Wideband Tracking and Communication System

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This report briefly discusses a design effort for a prototype Ultra-Wideband (UWB) Tracking and Communication System that is currently under development at NASA Johnson Space Center (JSC). The system is being designed to provide tracking and communication (audio/video) capabilities to the personnel working in and around the launch pad structures at Kennedy Space Center for safety enhancement. The UWB technology is exploited to implement this integrated tracking and communication system due to the technology's properties such as high data rate, fine time resolution, low power spectral density, and multipath immunity. The UWB Systems Group at JSC has developed a UWB two-cluster Angle of Arrival (AOA) Tracking Prototype System, which can provide long-range tracking capability. In this design effort, the communication functionalities (two-way voice and one-way video) are integrated into this tracking system. This report summarizes the development effort with system design configuration and field tests that validate the system's integrated tracking and communication capabilities.

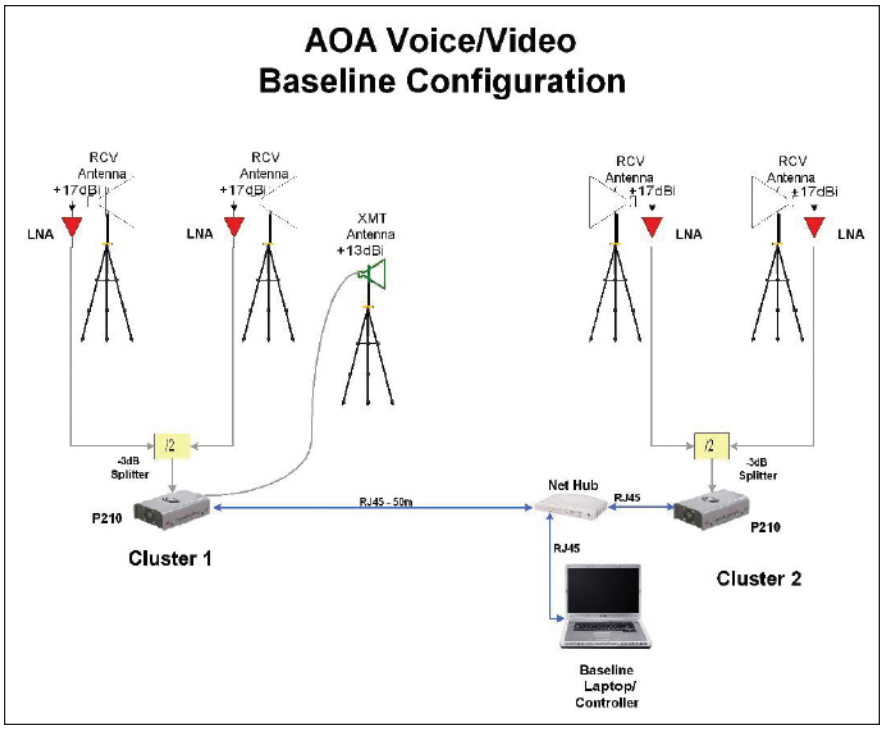

Fig 1. *Baseline configuration of integrated Ultra-Wideband Tracking and Communication System.*

System Design

The extremely high fidelity of the UWB timing circuitry permits precise measurements of propagation time while transmitting data. A key element of the tracking system design philosophy is to avoid introduction of system components or structure that would in any way degrade the fine time resolution of the UWB signal since it is critical for precise tracking. In keeping with this goal, the AOA technique using time-difference-of-arrival estimates is adopted for tracking to avoid the degradation in time resolution introduced by synchronization errors between the transmitter and receiver. A two-cluster prototype tracking system has been designed. This system connects two antennas through a power combiner to one UWB radio at each cluster using low-loss, phase-aligned interconnect cables with precisely calibrated delays. A two-way link is required for two-way voice/one-way video communication. An additional antenna is connected to the transmitting port of one cluster radio. Baseline configuration is illustrated in figure 1. Baseline consists of two clusters. Each cluster has one UWB radio with two receiving horn antennas (+17 decibels [dB]) connecting to its receiving port through low-noise amplifiers and power combiner. In cluster one, a transmitting horn antenna (+13 dB) is connected to the transmit port of the radio. Both radios are connected to the baseline control laptop through a hub. The configuration on the target side is illustrated in figure 2. The target carries a backpack with one UWB radio and power supply inside. The radio is connected to two omni-antennas for both transmitting and receiving. A netbook computer is connected to the radio for control and display. Headset, microphone, and web camera are all connected to the

netbook for audio and video communication. The AOA tracking software is developed in house. A commercial off-the-shelf application software VSee is used for audio and video communication.

Field Test

The test of the integrated UWB tracking and communication prototype system has been conducted at the antenna test range behind Building 14 at JSC. The test setup is shown in figure 3. On the baseline side, two clusters are set up with baseline size of 35 m (~115 ft) and antenna distance of 15 m (~49 ft) in each cluster. On the target side, the test personnel carry a backpack with a UWB radio and transmit/receive antennas mounted on a pole. He or she also carries a portable computer for control and display. A calibration point is set as (0, 303) m ([0, ~ 995] ft). The test shows that the system can track the moving target and maintain audio/video communication between target and baseline up to the range of 366 m (~ 1200 ft). The quality of two-way voice is very good and the quality of one-way video is good. The tracking data update rate is up to 10 hertz.

Conclusion

An integrated UWB tracking and communication system has been designed, implemented, tested, and proven feasible for tracking a moving target as well as communicating with the target through voice and video. These integrated capabilities can enhance the safety of the launch personnel at Kennedy Space Center. This system can also serve as a test bed for the lunar surface tracking and communication in the future. Future work includes expanding the system capability to track and communicate with multiple targets using the concept of reverse tracking.

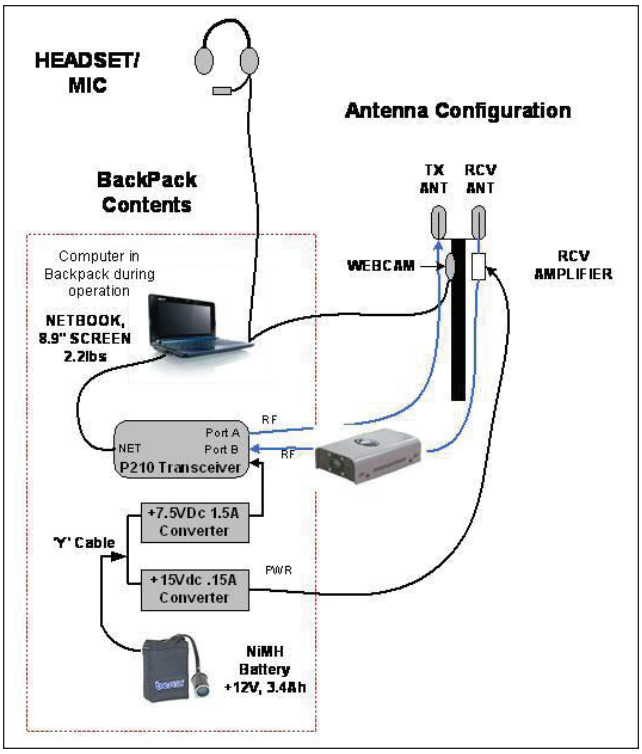

Fig 2. *Target configuration of integrated Ultra-Wideband Tracking and Communication System.*

Fig 3. *Integrated Ultra-Wideband Tracking and Communication System test setup (target and baseline).*